Separate H2 and CO production from CH4-CO2 cycling of Fe-Ni

Bo Jin[1], Nadadur Veeraraghavan Srinath[2], Hilde Poelman[3], Christophe Detavernier [2], Zhiwu Liang[4], Guy Marin[2], and Vladimir Galvita[5]

[1]Hunan University
[2]Ghent University
[3]Affiliation not available
[4]Joint International Center for CO2 Captu
[5]Universiteit Gent

November 20, 2021

Abstract

Fe-Ni materials with varying Ni loading are developed for separate H2 and CO production by CH4-CO2 chemical looping. The product streams are obtained by first feeding CH4, which decomposes to H2 and carbon. The latter acts as reductant for the subsequent CO2 feed, which together with Fe re-oxidation yields CO. After 25 CH4-CO2 cycles, 10Fe5Ni@Zr has a higher H2 space-time-yield than 10Fe0Ni@Zr (⟦20mmol[?]s⟧ ˆ(-1)[?]kg_(Fe+Ni)ˆ(-1) vs. ⟦15mmol[?]s⟧ ˆ(-1)[?]kg_(Fe+Ni)ˆ(-1)), a 2.6 times higher CO (⟦57mmol[?]s⟧ ˆ(-1)[?]kg_(Fe+Ni)ˆ(-1)) and lower deactivation. This improvement has two reasons: (i) CH4 activation over Ni leading to cracking, (ii) product hydrogen causing deeper FeO reduction. Deactivation follows from accumulated carbon, non-reactive for CO2. On Ni and Fe sites, carbon can be removed by lattice oxygen or CO2, yielding more CO compared to the theoretical value for Fe oxidation. However, carbon that migrates away from the metals requires oxygen for removal, which restores the activity of the Ni-containing samples.

Hosted file

Bo_Jin_Manuscript_29102021_AIChE J.docx available at https://authorea.com/users/447230/articles/546251-separate-h2-and-co-production-from-ch4-co2-cycling-of-fe-ni